



# An Interface Revolution: Gestural Computer Interfaces

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# Problem

- Is it feasible to construct and program a low cost, scalable, multi-touch gestural interface?

# Background Knowledge

- A multi-touch input is an interface device that can register multiple points of contact simultaneously.
- Frustrated Total Internal Reflection occurs when light is totally internally reflected within a material, and then an object with a different index of refraction is brought into contact, causing light that was totally internally reflected to scatter at the point of contact.



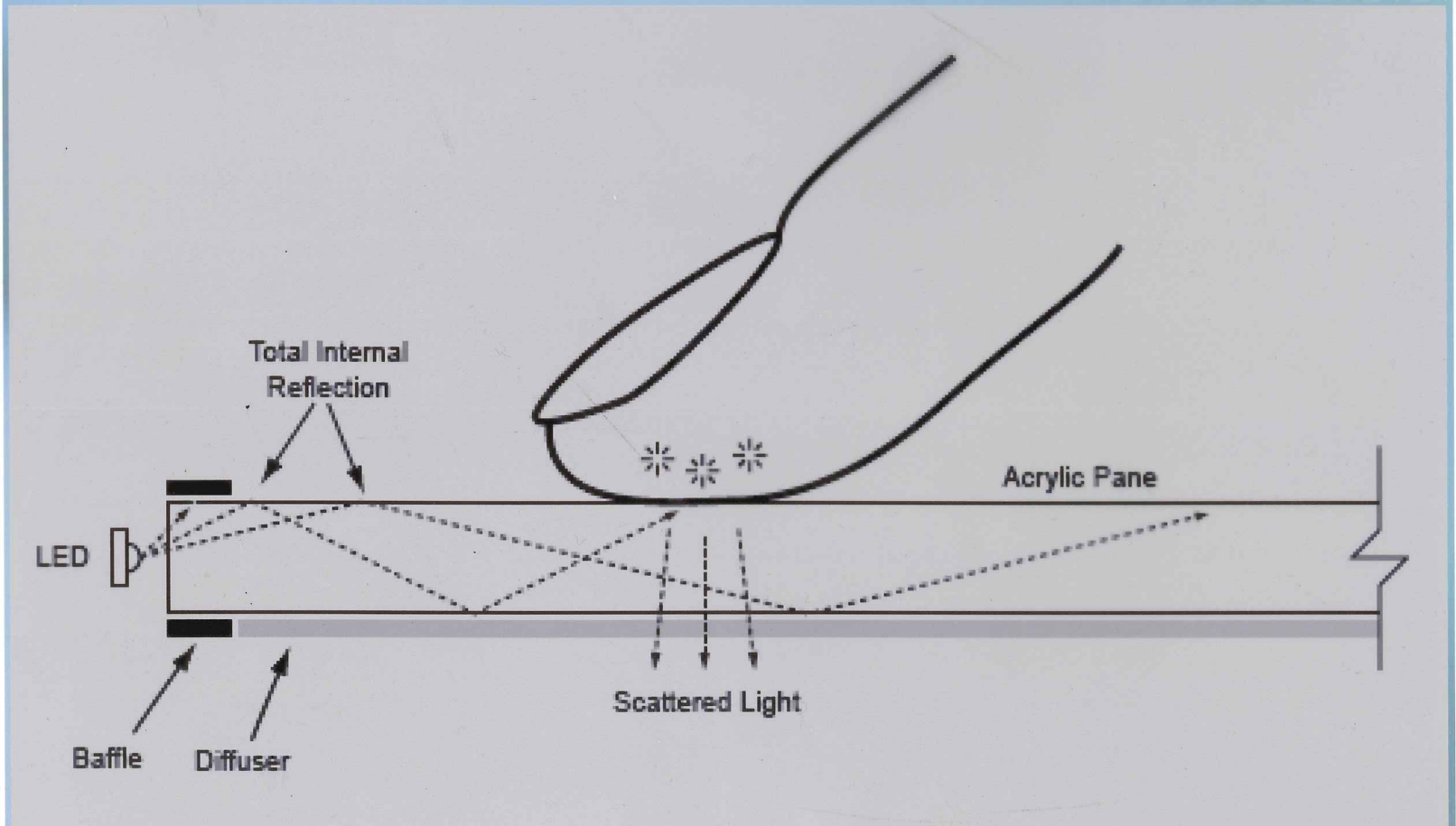
# Background Knowledge Cont.

- Processing is a programming language built on Java designed for multi-media applications.
- VVVV is a programming language which uses pre-written blocks of code connected together to create what are known as patches, used for rapid prototyping.
- OSC stands for open sound control. It is a protocol for communication between digital devices over a network connection.

# Hypothesis

- If one implements the technique of frustrated total internal reflection in the construction of a multi-touch input, then, through programming the device, it will be possible to produce an affordable gestural computer interface.

# Frustrated Total Internal Reflection





# Materials

- 40 IR LEDS
- Hookup Wire
- 5 Sheets of Plywood
- 2 Pieces of Acrylic
- Aluminum C Channel
- 1 12V Power Supply
- 1 Computer
- 1 Webcam
- 1 Mirror
- 1 LCD Projector

# Procedure

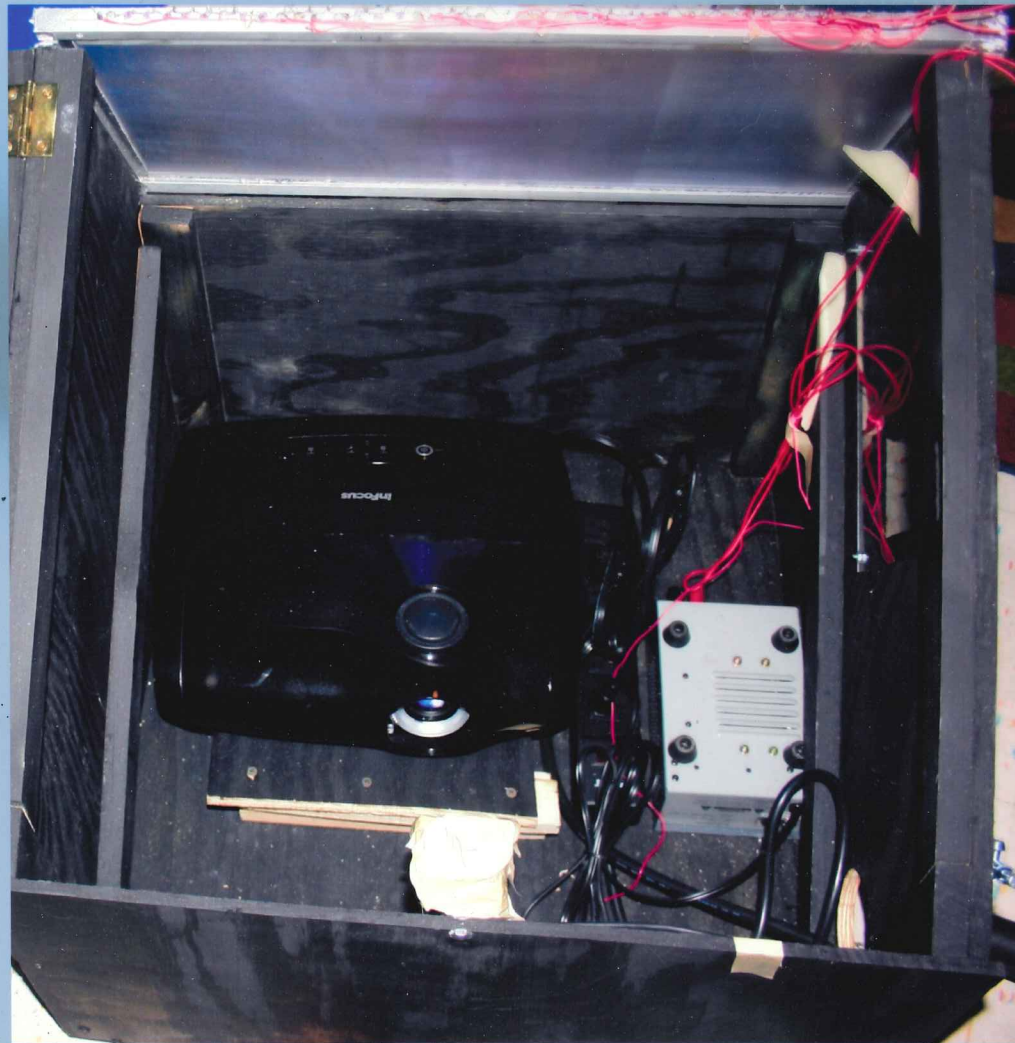
1. Construct multi-touch input device
2. Interface webcam with computer
3. Setup background removal algorithm in VVV
4. Setup blob recognition software in VVV
5. Enable inter-software communication using OSC in VVV
6. Create blob identification and tracking algorithms in Processing
7. Code multi-touch user interface in Processing
8. Create gesture recognition algorithms in Processing
9. Test all hardware and software systems
10. Draw conclusions and report findings



# Front of Box

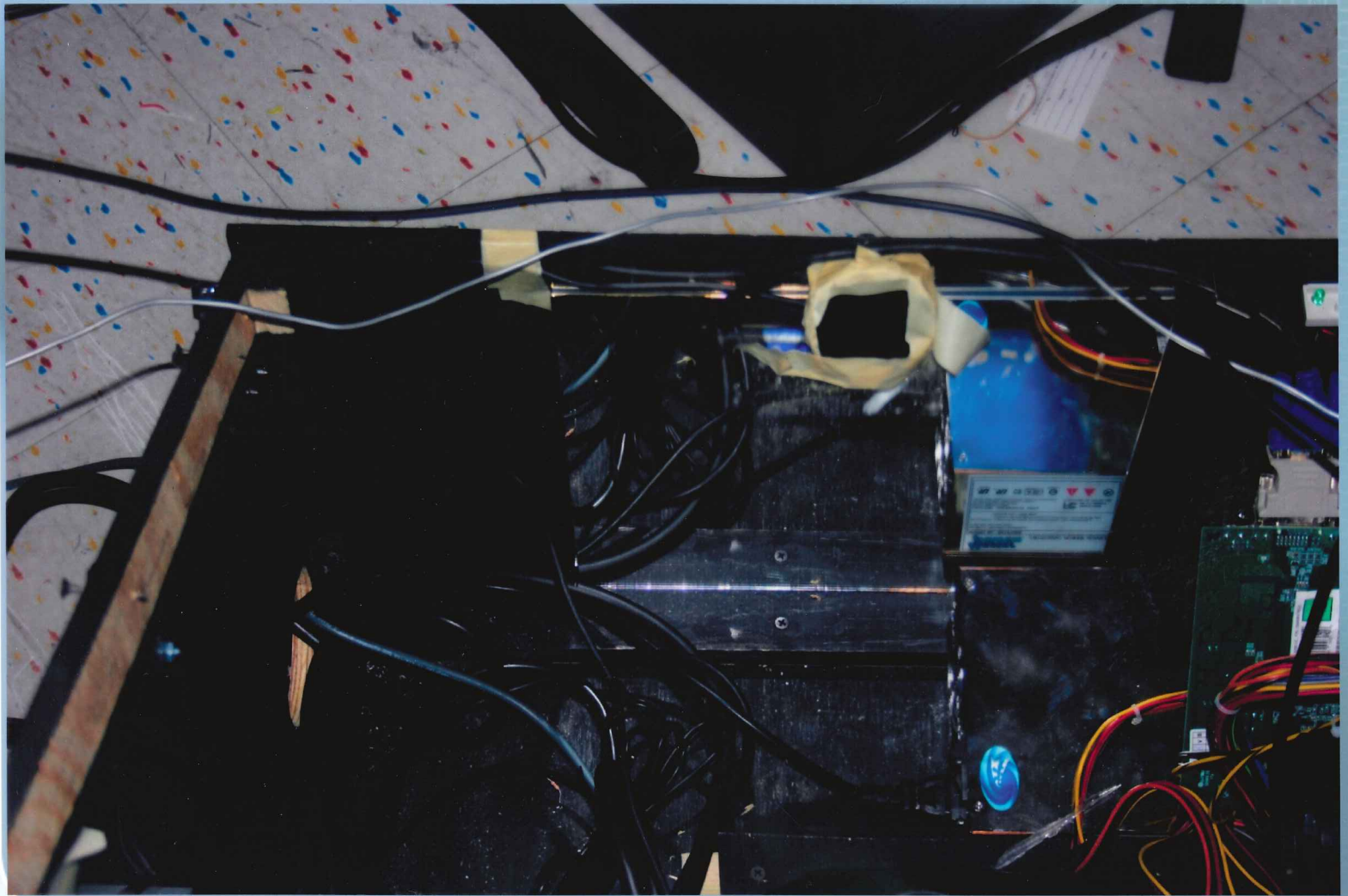


# Inside of Box



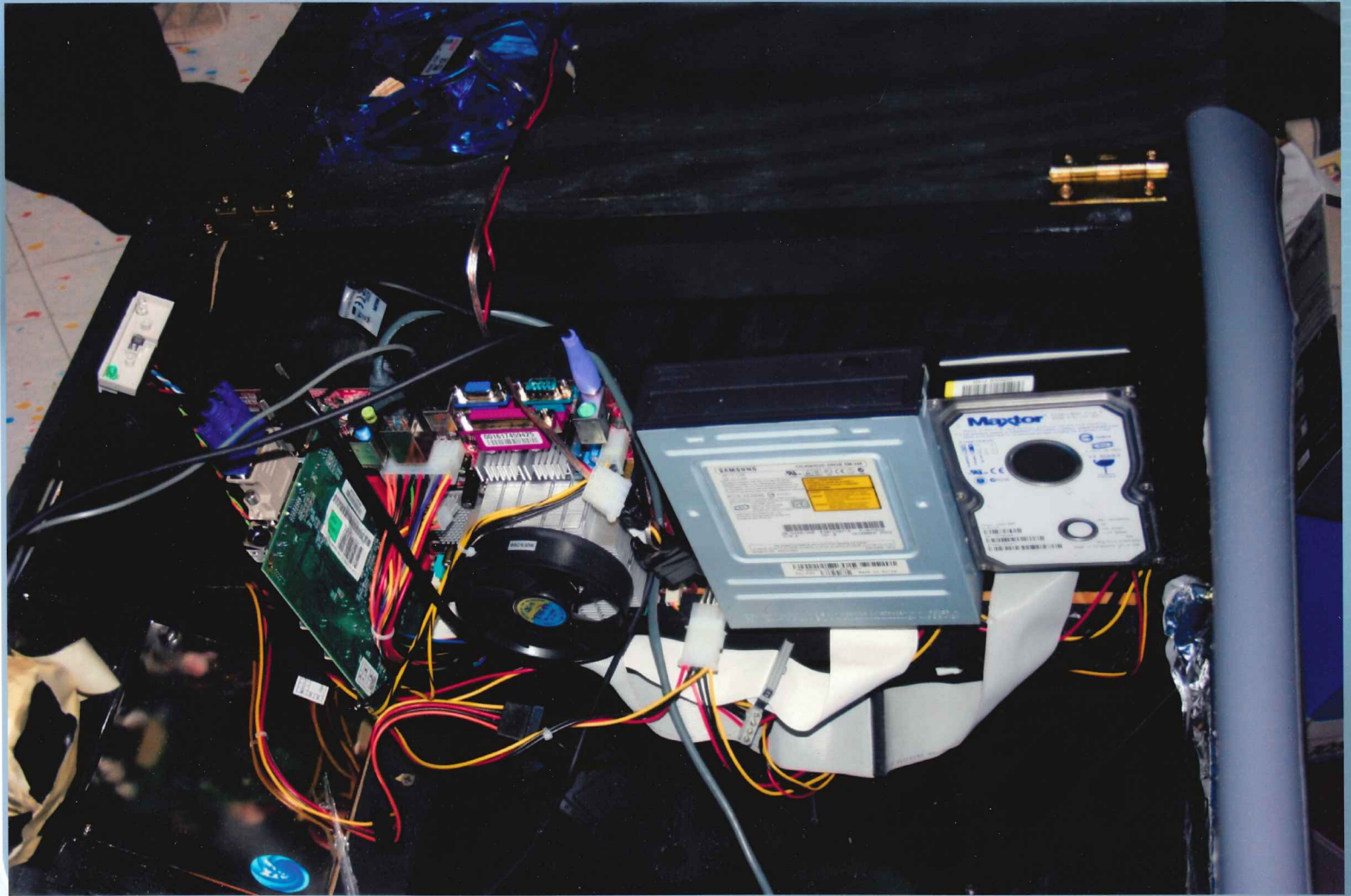


# Camera and Mirror

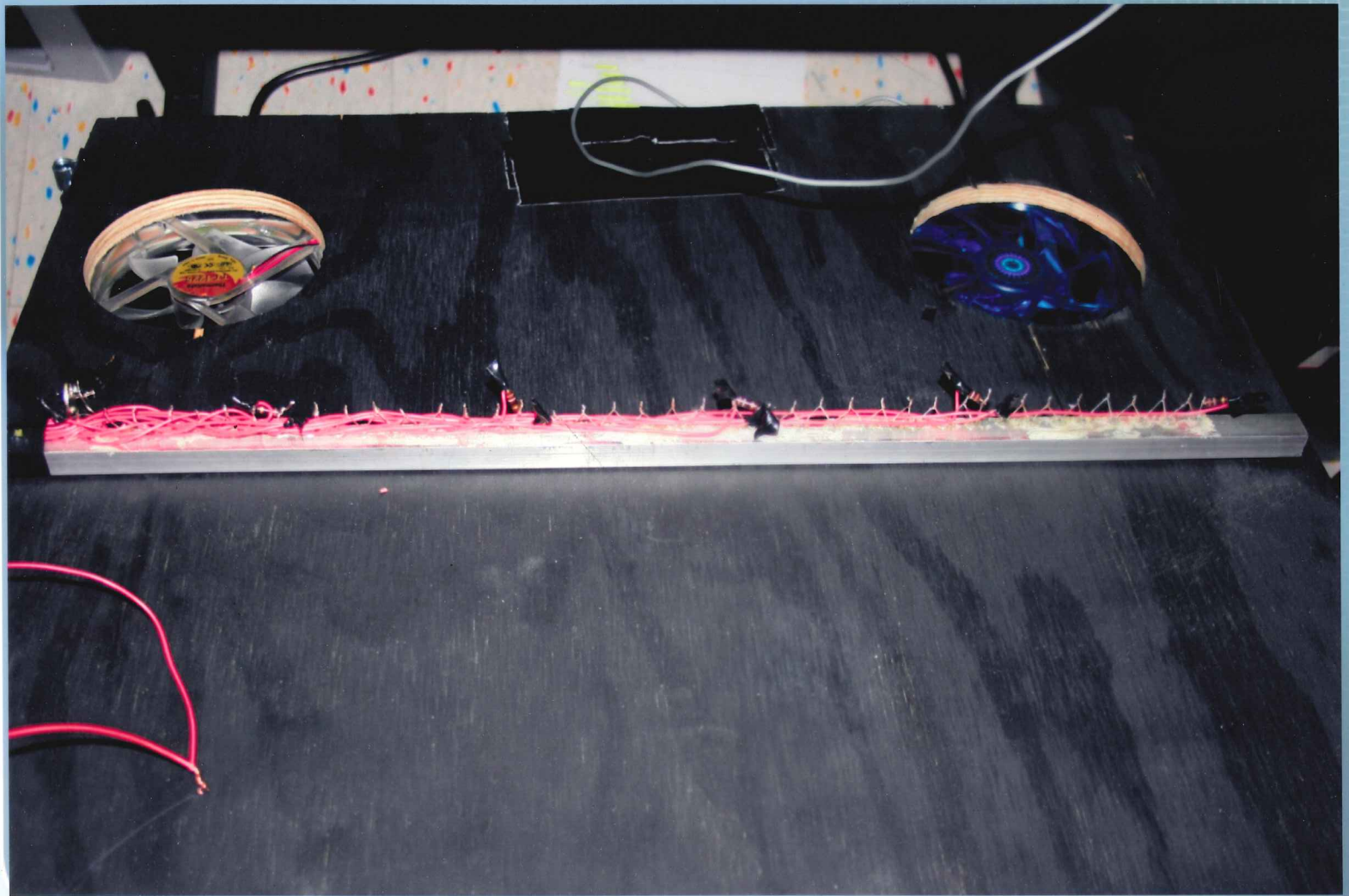




# Computer Within Box



# LED Array





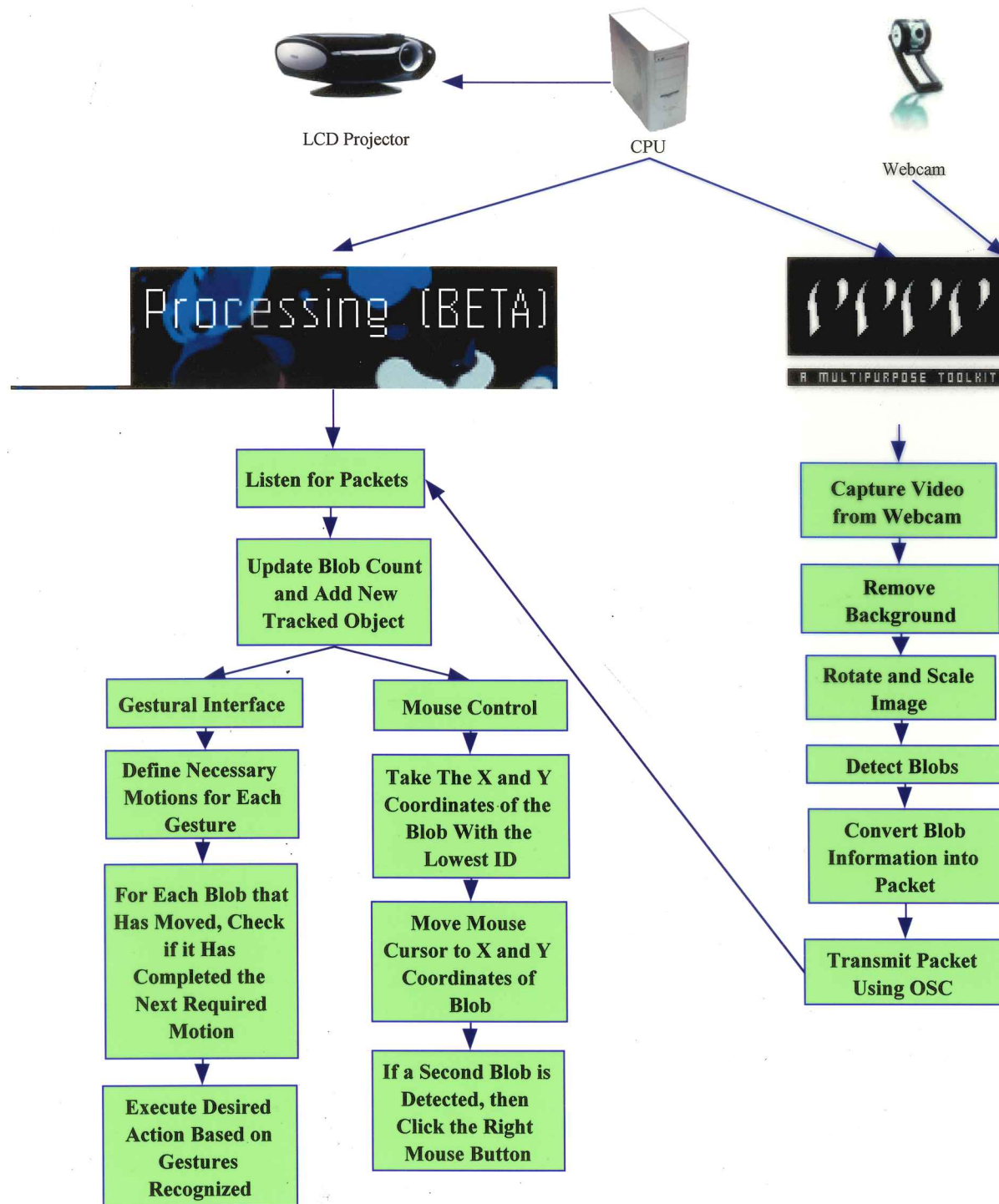
# Raw Camera Input





# Programming Languages

- VVVV: Used for webcam capture, background removal, blob detection, and OSC packet generation
- Processing: Receives packet from VVVV, then creates new blob objects from blobs detected. All user interfaces are coded in Processing, along with all gesture recognition functions.



# Processing Coding

- All gestures are defined by the angles one makes while performing said action.
- Here is an example from the code, for the circle:

```
GESTURES[2] = new Gesture();  
GESTURES[2].setName("Circle");  
GESTURES[2].setID(2);  
GESTURES[2].setDir(-135);  
GESTURES[2].setDir(180);  
GESTURES[2].setDir(135);  
GESTURES[2].setDir(90);  
GESTURES[2].setDir(45);  
GESTURES[2].setDir(0);  
GESTURES[2].setDir(-45);  
GESTURES[2].setDir(-90);
```

- The Java.AWT.Robots class is used to control the Windows pointer, creating multi-touch capabilities for the Windows environment.
- When a packet is received, the x and y coordinates, blob area, and ID are extracted and stored in a TrackedObject so that operations based on blob location may be carried out.

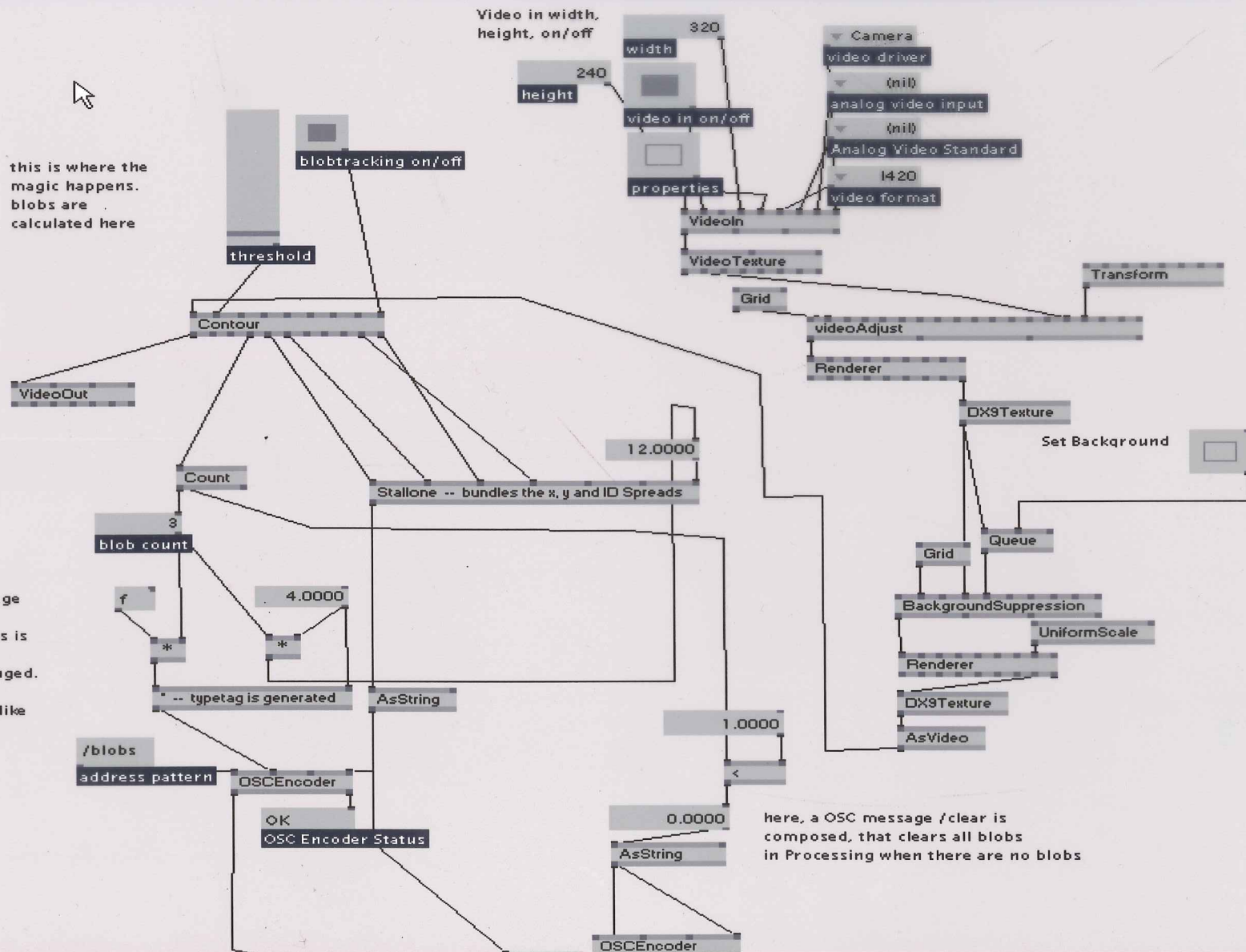


# VVV Coding

- Programming in VVV is accomplished by connecting pre-written node functions together to create a patch.
- Each node has different pins for input and output, taking different parameters such as numbers or video data.
- Renderers convert layers into textures.
- Pixel Shaders may be written, which utilize the GPU (Graphics Processing Unit) for processing power, which saves CPU (Central Processing Unit) power for other tasks.
- VVV makes use of the Microsoft DirectX API and its functions for many video and imaging tasks.
- Patches are compiled in real time, allowing for rapid prototyping and easier debugging.

# WWW Patch

updated patch.v4p \* C:\Documents and Settings\Administrator\Desktop\





# Analysis

- The software currently uses a high percentage of the CPU. This can be reduced by better making use of pixel shaders.
- The screen has trouble tracking quickly moving points. By implementing a compliant surface, the screen would be able to better handle moving blobs.
- The gestures are very sensitive as a result of the methods used for detection. Better algorithms could be coded in the future to better account for difference in interpretation.
- In addition to the ability to left click in the multi-touch Windows interface, a right click method would be necessary for full implementation into daily use.



# Practical Applications

## ■ Military:

- Mass Data Processing
- Troop Movement Monitoring
- Strategic Planning / Map Reading

## ■ Disabled Computer Users:

- Gestural interfaces can be used in conjunction with retina tracking in order to enable those who do not have use of their arms to use a computer to both communicate and work

## ■ Collaboration:

- Children can learn about working together while collaborating on a multi-touch screen
- Plans and other business documents can be easily manipulated and viewed by multiple people simultaneously

## ■ Carpel Tunnel Syndrome:

- As a result of no longer needing to conform to hardware, users can avoid diseases such as Carpel Tunnel which result from the unnatural positions that computer hardware creates.

# Inspiration

- The primary inspiration was the movie *The Minority Report* where the detectives used a futuristic gestural interface to process large amounts of video information in an extremely short period of time.
- After further research, I learned about the work of Jefferson Han, a professor at NYU. I viewed his presentation at the TED Conferences, and learned some of the amazing potential available as a result of multi-touch inputs
- I enjoy the challenge of both constructing a working prototype and also writing the software to make it interact with computers.



# Conclusion

- My hypothesis is indeed correct in that it is possible to construct and program an economical multi-touch gestural interface.
- Gestures are able to be used to interface with the computer, and the computer can also be controlled using multi-touch input.
- Future Experimentation:
  - Construct a larger touch device
  - Code more gestures that can be used to control the computer
  - Create virtual environments for multi-touch input
  - Work with large data processing such as maps or schematics
- What I learned:
  - Two new languages, VVV and Processing
  - New techniques for hardware / software interfacing
  - How to create Graphical User Interfaces



# Bibliography

- Han, Jeff. Jeff Han's Multi-Touch Sensing. 1 11 2006 <<http://www.youtube.com/watch?v=zwGAKUForhM>>.
- —. Multi-Touch Interaction Research. 1 11 2006 <<http://cs.nyu.edu/~jhan/ftirtouch/>>.
- —. Multi-Touch Sensing through Frustrated Total Internal Reflection. 1 11 2006 <<http://www.cs.nyu.edu/~jhan/ftirsense/index.html>>.
- —. Multi-Touch Sensing through LED Matrix Displays. 1 11 2006 <<http://cs.nyu.edu/~jhan/ledtouch/index.html>>.
- Han, Jefferson Y. "Low-cost multi-touch sensing through frustrated total internal reflection." Proceedings of the 18th annual ACM symposium on User interface software and technology. Seattle, WA: Symposium on User Interface Software and Technology, 2005. 115-118.
- Howard, Andrew, et al. The MIDI Glove. 1 11 2006 <<http://www1.cs.columbia.edu/~ahoward/midiglove.htm>>.
- Lee, S. K., W. Burton and K. C. Smith. "A Multi-Touch Three Dimensional Touch-Sensitive Tablet." Proceedings of the SIGCHI conference on Human factors in computing systems. New York, NY: ACM Press, 1985. 21-25.
- Morrison, Gerald D. A Camera-Based Touch Interface for. Pervasive Displays. 23 10 2006 <[http://ubicomp.algoritmi.uminho.pt/perdisplay/docs/Morrison-Camera%20Touch\\_SV\\_Rev1.pdf](http://ubicomp.algoritmi.uminho.pt/perdisplay/docs/Morrison-Camera%20Touch_SV_Rev1.pdf)>.
- Open Computer Vision Library. 1 11 2006 <<http://sourceforge.net/projects/opencvlibrary/>>.
- Saga Media. Multi Touch Input Video and Technology. 1 11 2006 <<http://www.multitouchinput.com/index.shtml>>.
- scdiroff. Tunneling Analog. 23 10 2006 <<http://www.fas.harvard.edu/~scdiroff/lds/QuantumRelativity/TunnelingAnalog/TunnelingAnalog.html>>.
- Shanis, Jenna and Alan Hedge. "An Exploration of Multitouch Technology." 10 2003. Human Factors and Ergonomics Society 47th Annual Meeting. 1 11 2006 <[http://ergo.human.cornell.edu/Conferences/HFES03/Multitouch\\_HFES03.pdf](http://ergo.human.cornell.edu/Conferences/HFES03/Multitouch_HFES03.pdf)>.
- The DataGlove Project. 1 11 2006 <<http://www.geocities.com/mellott124/DataGlove.htm>>.
- VR Depot. INTEGRATED FAKESPACE GLOVE & LOGITECH TRACKER IMAGE. 1 11 2006 <<http://www.vrdepot.com/trkglv.htm>>.
- Wu, Andy, et al. Multi-touch Interactive Wall Displays. 23 10 2006 <<http://interactivedisplays.blogspot.com/>>.
- ZEMAX. Polarisation and Coatings. 23 10 2006 <<http://www.optima-research.com/Software/Optical/Zemax/polarization.htm>>.
- IRC Channel #FTIR and #Processing
- <http://whitenoiseaudio.com/>
- <http://sport4minus.de>
- Vvvv.org
- Processing.org